if he wishes, and from that point of view the following publications by the Meteorological Office are regarded as suitable:

FORECASTS.

1. The *Daily Weather Report* with the provisions set out for telegraphing forecasts for a small fee to those who are willing to pay for the telegrams.

Forecasts are prepared throughout the year each morning at 10 a. m. and each evening at 7 p. m., and during the harvest season—June to September—in the afternoon, specially for agriculturists.

STATISTICS.

2. The *Weekly Weather Report*, which was projected specially with a view to agriculture and public health, gives a summary of the pressure, temperature, sunshine, and wind in a form which was designed to be specially suitable for agricultural purposes. This report has now been continued for 36 years and forms a homogeneous body of statistics week by week, which is, for that purpose, probably unrivaled in the world. But it has a very small circulation outside official circles.

3. The *Monthly Weather Report* which gives the usual climatological information for about 300 stations in the British isles.

In actual practice these provisions are very little used by agriculturists. Many persons are willing to receive forecasts by telegraph, but are unwilling to pay for the telegrams; it is entirely contrary to the instinct of the British race to pay for anything until its value has been made undeniably clear, so that the farmer and the Govment are both waiting for the utility of the forecasts to be demonstrated beyond cavil. Yet that can only be done by trial, and nobody has yet been found who is willing to pay the cost of an adequate trial on a large scale. The Meteorological Office could, if the committee wished, undertake that experiment, but it would mean diverting some of its funds from meteorological study to meteorological applications. It is naturally disposed to make quite sure of success before it embarks on a speculation of that kind, and certain success is the reward [only] of careful study. No institution with scientific instincts is disposed to commit itself to the position that its knowledge is complete and that it can forego any further investigation, especially in such a subject as the study of weather.

The climatological aspect of *la météorologie agricole* is a matter of the greatest difficulty. The practical farmer has made his own study of weather and used it in his own way without committing the results to writing. The Meteorological Office commits a vast number of figures to print without knowing what their precise application to agriculture is. All are agreed that agriculture depends upon weather, but to ascertain the manner in which the figures of the meteorologist can be applied to supplement the farmer's practical experience of weather is a matter requiring something that approaches to genius.

The relations between the Meteorological Office and the boards of agriculture in the United Kingdom are of the happiest, but neither side knows exactly how nor where to begin. Some progress has, however, been made in this country. Some years ago the Meteorological Office issued a note about the wheat crop in relation to the rainfall of the previous autumn, and this was taken up by a member of the staff of the Board of Agriculture, who produced a most valuable discussion by modern statistical methods of the relations of weather and crops for one district of England.

EDUCATION.

The further development of the application of meteorology to agriculture is largely dependent upon education in rural schools. The study of weather is now becoming a part of education in many schools, rural as well as urban, so that the prospect of more effective organization is good. The provision for this is shown in Circular E .03.

But thus far as regards organization, at present the formal responsiblity of the Office is limited to preparing forecasts and compiling statistics which will be indispensable when further investigation has so far developed the laws of weather as to allow of forecasting coming seasons.

That is one of the avowed objects of the *réseau mondial*, and the work thereupon must therefore also be regarded as a contribution to *la météorologie agricole*, although the practical farmer would probably not so regard it.

ANSWERS TO INQUIRIES.

Perhaps the most valuable provision of the Meteorological Office at the present stage is the provision for answering inquiries about the weather on the part of the general public. Any public department and any private person may ask any question that can be answered by a knowledge of the facts and laws of weather, and to such questions answers are given with all the intelligence that the Office can command. Many inquiries are answered, and the inquirer often finds the Office to be possessed of information of which he was unaware.

This provision allows inquiry to be directed along the lines which the agriculturist opens; among the subjects which have already been the subject of inquiry may be mentioned—spring frosts, and the protection of vegetation by "smudging"; autumn frosts; the effect of gunfire upon rainfall, particularly during harvest; spells of fine weather for harvest; temperature in relation to sugar growing; the limits of forestation prescribed by temperature; atmospheric humidity in relation to brewing.

By watching the trend of these inquiries, and by the organization of the means of preparing intelligent replies, the Meteorological Office hopes to approach the question of *la météorologie agricole* on lines suggested by agriculturists themselves, and at the same time by encouraging the development of weather study in schools to lead up to the spontaneous use of the information compiled in the Office.

If necessary, the form of the information which meteorologists have hitherto put forward as representing the main features of climatology will be altered so as to meet the needs of the agricultural inquirer.

In fine, it may be said that at present the Meteorological Office is more concerned with the means for organizing *la météorologie agricole* on a satisfactory basis than with any organization actually in operation.

WEATHER BUREAU EXHIBIT AT SAN FRANCISCO, 1915.

By J. CECIL ALTER, Observer in Charge.

[Dated: Denver, Colo., Sept. 7, 1915.]

The allotment of space for the United States Weather Bureau exhibit at the Panama-Pacific International Exposition was made early in July, 1914, and a detailed outline of the exhibits, and the proposed arrangement, prepared, which was approved by the chief of bureau, and by the representative of the Agricultural Department on the Government Exhibit Board.

About 700 visitors to the Weather Bureau exhibit were estimated from partial count the first afternoon, February 20. There being no provision for illuminating the exposition palaces, the exhibits were closed at 6 p. m., and

FIG. 1.

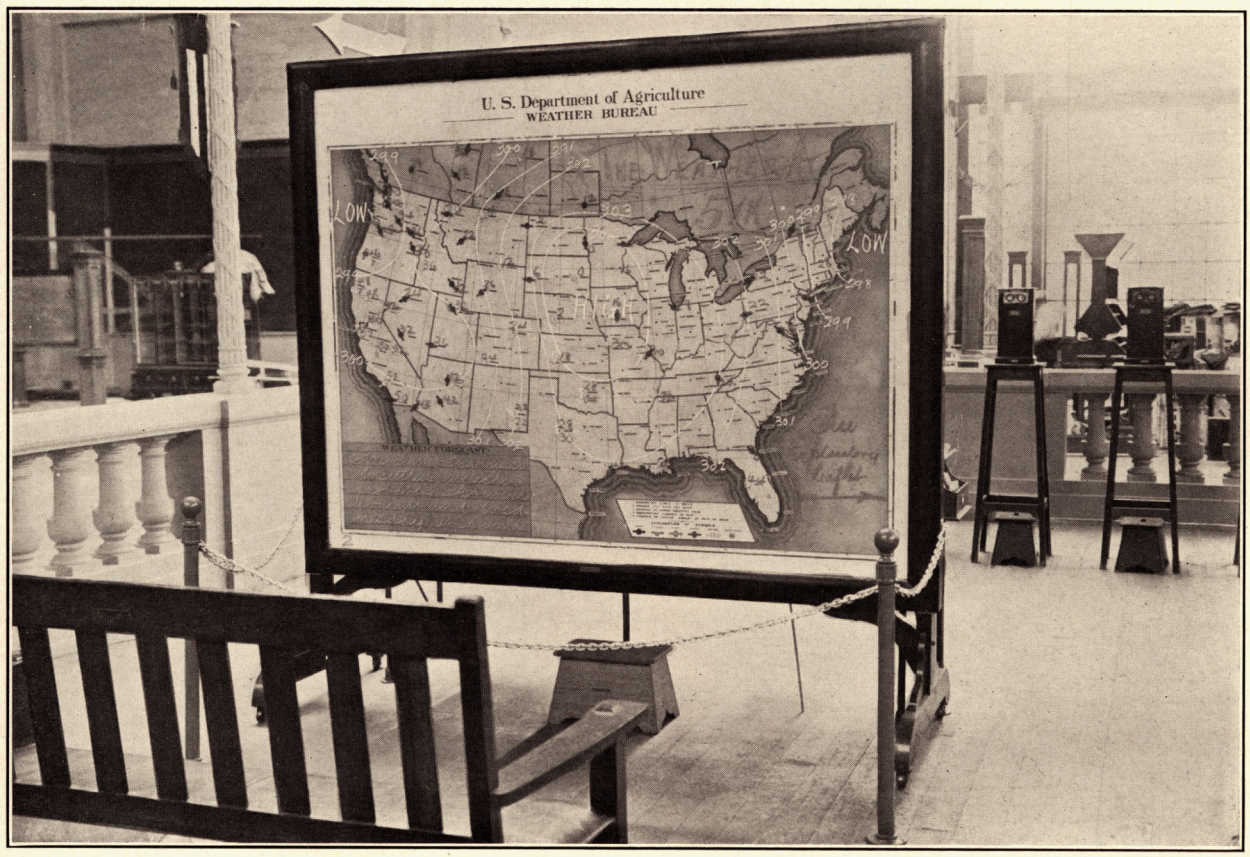

FIG. 2.

WEATHER BUREAU EXHIBIT AT PANAMA-PACIFIC EXPOSITION.

To face page 452.

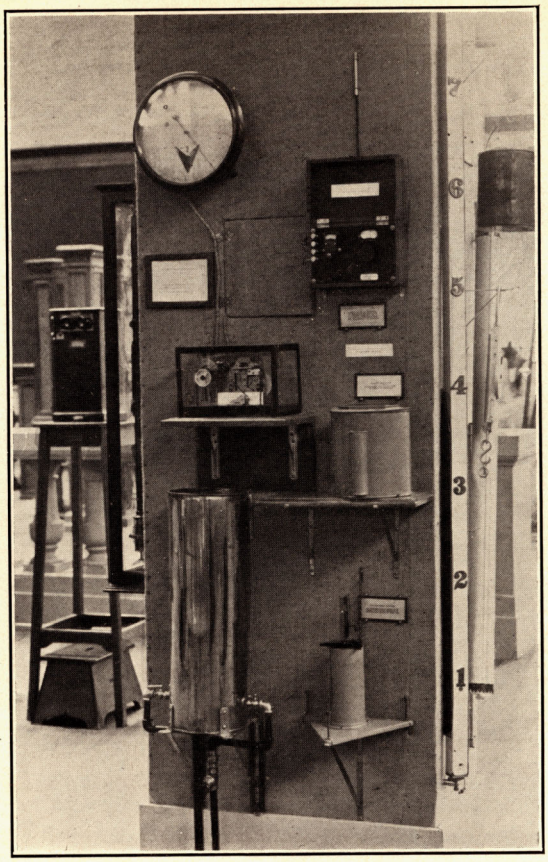

FIG. 3.

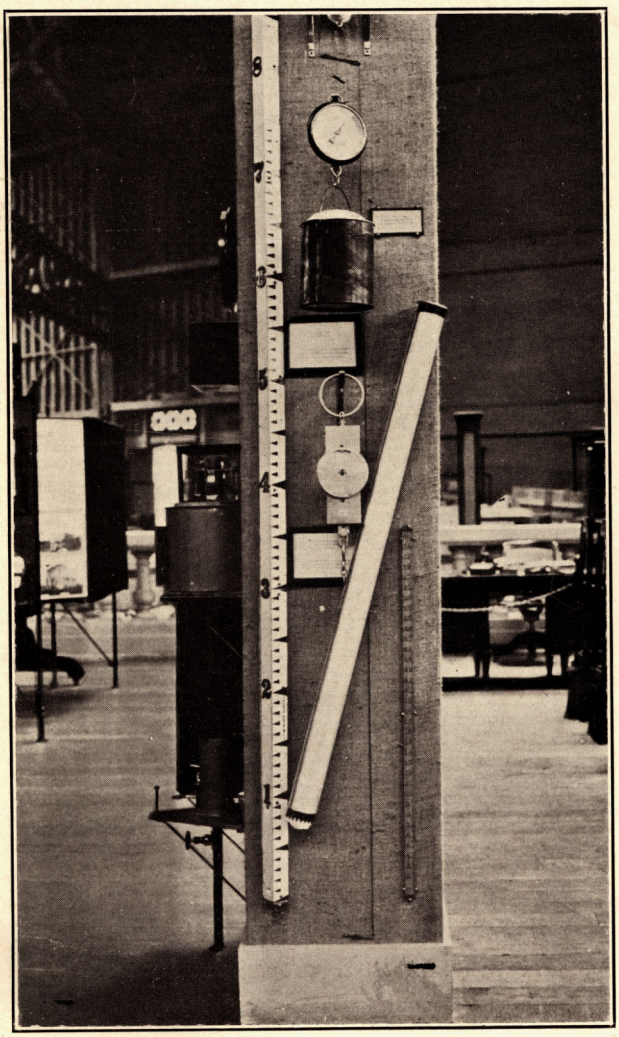

FIG. 4.

FIG. 5.

WEATHER BUREAU EXHIBIT AT PANAMA-PACIFIC EXPOSITION.

opened each morning at 9 o'clock, except Sundays, until in April, when the Government Exhibit Board managing all exhibits made by the Government, left the roped entrances to the Government exhibits open on Sunday.

In February the approximate total attendance in the Weather Bureau exhibit, estimated from occasional actual count, was 1,800; March, 4,700; April, 6,100; May, 9,300; June, 10,500; July, 11,000; and August, 11,000, many being high school and college classes, all of whom spent more or less time examining the exhibits and listening to demonstrations.

The exhibit occupies a space 28×59 feet (1,652 square feet) in size, located near the south or main entrance to the Palace of Agriculture, being a corner of the area occupied by the Department of Agriculture. The main avenue through the palace, 16 feet wide, bounds the space on the west, an aisle 12 feet wide and the Government-space balustrade form the south and the east boundaries, and a 7-foot passageway at the north separates the Weather Bureau space from other bureau exhibits. The agricultural exhibits of the Argentine are across the south and east aisles.

The exhibit is open in arrangement, a view being afforded of practically the entire space from every side and corner. The floor space actually occupied by the stands, tables, instruments, and the massive balustrade is only 17 per cent of the total exhibit space allotted to the bureau.

The cases, tables, and other furniture are finished in light oak, giving a uniform and pleasing appearance on the oiled pine floor. The glass weather map, the wind-instrument tower carrying its active instruments, the model storm-warning tower, the kite and the balloon suspended above the general exhibits are visible from all adjacent exhibits.

The new 8-foot glass map of the United States, upon which the prevailing weather conditions throughout the country are placed each morning, fronts the north aisle at the east end of the space and a large settee in front of the map upholstered in leather, is usually well patronized. A low chain on posts serves as a railing in front of the map. The weather reports are received by telephone through the courtesy of the officials at the San Francisco office of the bureau, the map being completed about 11 a. m. daily. (See fig. 2.)

A small literature rack at the end of the map frame carries for free distribution the booklet, The Weather Bureau, the leaflet, Explanation of the Weather Map, and the card, Explanation of Weather Flags. The daily map printed at the local office of the bureau is also posted regularly near by, together with the National Weekly Weather and Crop Bulletin.

The principal instrument stand, located near the map, was specially made to suit the needs of the exhibit and to conform with the architecture and finish of all other Government furniture on display. There are three drawers on a side and space for the dry-cell batteries underneath. The size is 3×6 feet, the same as the station instrument stand. On it is shown the triple register in operation, being connected with the wind vane anemometer, raingage, and sunshine recorder, as usual on all regular stations, the two latter records being alternated for demonstration. Cards and labels on the case and on each pen explain the records briefly.

The thermometric sunshine recorder is rigidly mounted in the center of the table, a specially mounted electric lamp being placed adjacent to operate the recorder artificially as desired. A 16-candlepower lamp suffices. At the other end of the table is a single-register instrument recording wind velocity simultaneously with the wind-velocity pen on the triple register. On this stand also are the telethermograph (alcohol bulb pattern), the aneroid barograph, and the hair hygrograph, all in operation at correct values. Previous records are left near each instrument.

The raingage display stand, near the instrument stand, is 2×6 feet in size and 18 inches high. It carries the 8-inch gage complete, the tipping-bucket and the new Marvin weekly float gages; the last two are operated almost continually by running water from the city mains. Drainage is provided so that no attention is necessary, except to drain the contents of the float-gage reservoir occasionally while this gage is being operated. A record sheet containing rainfall records made on this new gage is exhibited in position on the gage by means of the special glass panels of the gage cover. (Fig. 5.)

The regular mercurial barometer case as supplied to stations is mounted on a building post in the midst of the exhibit space; a station mercurial barometer is shown, and by its side hangs another of similar pattern with the cistern partly cut away to show the mechanism.

The Marvin automatic river-stage indicator is exhibited on the side of this post; the stillwell, operating mechanism, and dial are connected on short circuit from batteries placed inside the framing of the post. The stillwell is provided with a water-supply pipe and a drainage cock, for ready demonstration of the instrument. A special glass cover is provided for the mechanism, so that its operation may be observed. The stillwell is near the floor, the mechanism about eye high, and the indicator dial about 7 feet from the floor. (Fig. 3.)

The new style telethermoscope is mounted on the same post surface with the river gage, its batteries (dry cells) being with others within the post. The bright bulb is placed just above the case, which is mounted on edge for better examination and operation.

The compensated siphon barograph, Marvin system, placed on a side of the building post, is recording continuously at current values.

The Marvin float-evaporometer, in its stillwell with water, is placed under the telethermoscope on brackets. The new evaporation tank, on proper wood base, containing the requisite depth of water continually, with improved hookgage installed, is located nearby on the floor, at proper elevation.

On another edge of the large post (fig. 4) is the snow measurement apparatus. The Marvin density tube and spring balance are mounted on a bracket. The copper pail and spring balance are on a bracket above the tube, and the Kadel snow stake is mounted cornerwise against the post to show its graduations; the 3-foot hickory measuring stick is made fast nearby.

An electric fan on a bracket above the snow measurement apparatus operates the anemometer about 7 feet away. Above the electric fan, and about 15 feet from the floor, is a large bracket carrying the 10-inch model storm-warning lanterns (oil burners). The lantern halyards are rove on a pulley and the lanterns may be lowered for examination.

The combined anemometer wind-vane support is anchored to the floor without braces or guys by means of bolts through the 3-inch floor. The anemometer runs at a velocity indicated at about 6 miles per hour continuously. The cups are about 11 feet from the floor, and

the 4-foot vane is 6 inches higher. The wind-direction contact box, about 3 feet from the floor, is left open for examination. The battery wires pass from the hollow support pipe under the floor to the triple register 15 feet away.

Nearby is a table carrying a model farm residence properly wired for lightning protection according to plans and specifications by A. J. Henry. Five dry cells and a spark coil such as is used in amateur wireless telegraphy, connected with the house wiring system and with a wire having a loose end, permit an attractive demonstration with this exhibit; when the loose end of the wire is brought near the tips of the lightning rods or any part of the house wiring system, a stream of crackling sparks will jump an air gap of about 1½ inches, and by a slight manipulation several streams of sparks may be produced, resembling lightning in appearance.

The major parts of the Marvin pyrheliometer, equatorial mounting, also stand on this table; the readnig telescope, scale, galvanometer, and other delicate parts are in a closed show case nearby. A photographic sunshine recorder, shown with exhibit base, is also on this table.

A low stand, 18 inches high and 3×6 feet in size, carries the model storm-warning tower, with its lanterns and the weather flags, the appropriate weather flags (small size) being displayed for to-morrow's weather forecast. The flags are about 17 feet from the floor. Small 6-inch models of electric storm-warning lanterns are about 12 feet from the floor and may be lowered for examination. A small brass model of the new Marvin shielded rain-and-snow-gage, one-fifth actual size, is mounted on the same stand.

A screen for displaying photographic prints is near the wind instrument tower. It has two surfaces about 6 by 6 feet in size for large illustrations and 12 views are shown. Nearby is an autoprojectoscope for automatically projecting lantern slides continually; a large leather upholstered settee in front of this picture machine invites visitors to rest a while. The views shown are about 2 feet square, each view being exposed about 15 seconds, though with a push-button cord any slide may be held as long as desired. Appropriate explanatory slides accompany each view or series of views, there being at least six views of every branch and special feature of the Bureau and its work.

At the southwest corner of the space is an exhibit transparency stand having two show cases beneath the transparency frame. (See fig. 1.) One case contains textbooks and Weather Bureau publications, with climatological statistics or averages for practically all parts of the world. The adjacent show case contains the Marvin nephoscope, complete; a kiosk aneroid barometer, and the same showing works only; a pocket aneroid barometer; the kite meteorograph, and the balloon meteorograph with extra aluminum sheets for records. All show cases are plush-lined, and have glass panels on sides and top.

A similar display stand with show cases is at the northwest corner of the space; one case carries the pyrheliometer parts, a short range thermograph (metal coil pattern), two ordinary thermometers, a maximum and a minimum thermometer on a Townsend support, a hand sling psychrometer, and a regular station whirling psychrometer, with shortened handle, and no support. The other case contains a Lambrecht's hygrometer, Marvin's kiosk hair hygrometer, a burette tube, an electric sunshine recorder, Lind's old style anemometer, a small zero-setting anemometer for light air movement, electrical contacts for wind direction registration, a Marvin kite anemometer complete, and a regular station anemometer with cups, these instruments having been taken apart when necessary to show them in the case.

Between the transparency stands, on the main aisle, is the Bosch-Omori seismograph in an exhibit case. The seismograph pen vibrates continually with the minute movements of the floor, though the record is not traced. Enlarged copies of records of the San Francisco earthquake in 1906, and others, are shown in the case. The pens, drum, and time-marking devices shown are by Marvin.

The Marvin box kite is suspended by a wire about 15 feet overhead and carries an empty aluminum meteorograph case. A sounding balloon is also suspended similarly, the empty meteorograph basket, attached properly to the overslung parachute, being just above visitors' heads. The balloon is inflated with compressed air. (Fig. 1.)

A display fixture containing 24 wing frames, providing for 96 surfaces, 22 × 26 inches in size, for photographs, charts, and maps, is placed against the back of the glass weather map. On this fixture, and on the picture screen, transparency stands, and lantern slide projector already mentioned, are shown several selected views each, of Weather Bureau buildings, mountain snow scenes, wireless stations, kites and balloons in use, cooperative stations, instrumental exposures at stations, many special single instruments where the instrument is not exhibited, river and flood views with river gages, the Wagon Wheel Gap (Colo.) experimental work, also the similar work at Ephraim, Utah, the frost work in the fruit regions, and in the cranberry marshes, copies of automatic records of special or historic storms, cloud and fog forms and types, snow and ice crystals, forecast verification map, West Indies storm tracks and Panama Canal sailing routes, long record precipitation charts, maps of all regular and special stations of the bureau, the corn, wheat, cotton, and other special services; consecutive series of Washington weather maps; series of the Northern Hemisphere maps; foreign weather maps; special diagrams of precipitation distribution by months at selected stations; the snow survey work in Utah; special storm views, showing tornado damage, waterspouts, hail, and damage thereby, lightning photographs and lightning effects, deep snow views, ice gorges in streams, vessel warning stations, vessel reporting service, coast storms and effects and other miscellaneous views.

Two stereoscopes each contain 48 views of the work in the central office of the bureau, the work at a typical climatological station (Salt Lake City), the snow measurement work with the Marvin tube and shielded gages, the cooperative experimental station at Ephraim, Utah, some river views, and a number of cooperative stations. (Fig. 2.)

CLIMATOLOGICAL STATIONS AND LOCAL AUTHORITIES.

We print below remarks by the director of the British Meteorological Office addressed to the local pride and local interests of Great Britain and Ireland. Probably the conditions of the time rather than the natural course of evolution of meteorological work, have influenced him in this case. The best interests of meteorology and of climatology require that so far as possible the equipment, installation, inspection, and observing methods be under a single centralized control. Only under such conditions can science be assured of that degree of reliability, uniformity, and homogeneity which is the prime essential